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Contents

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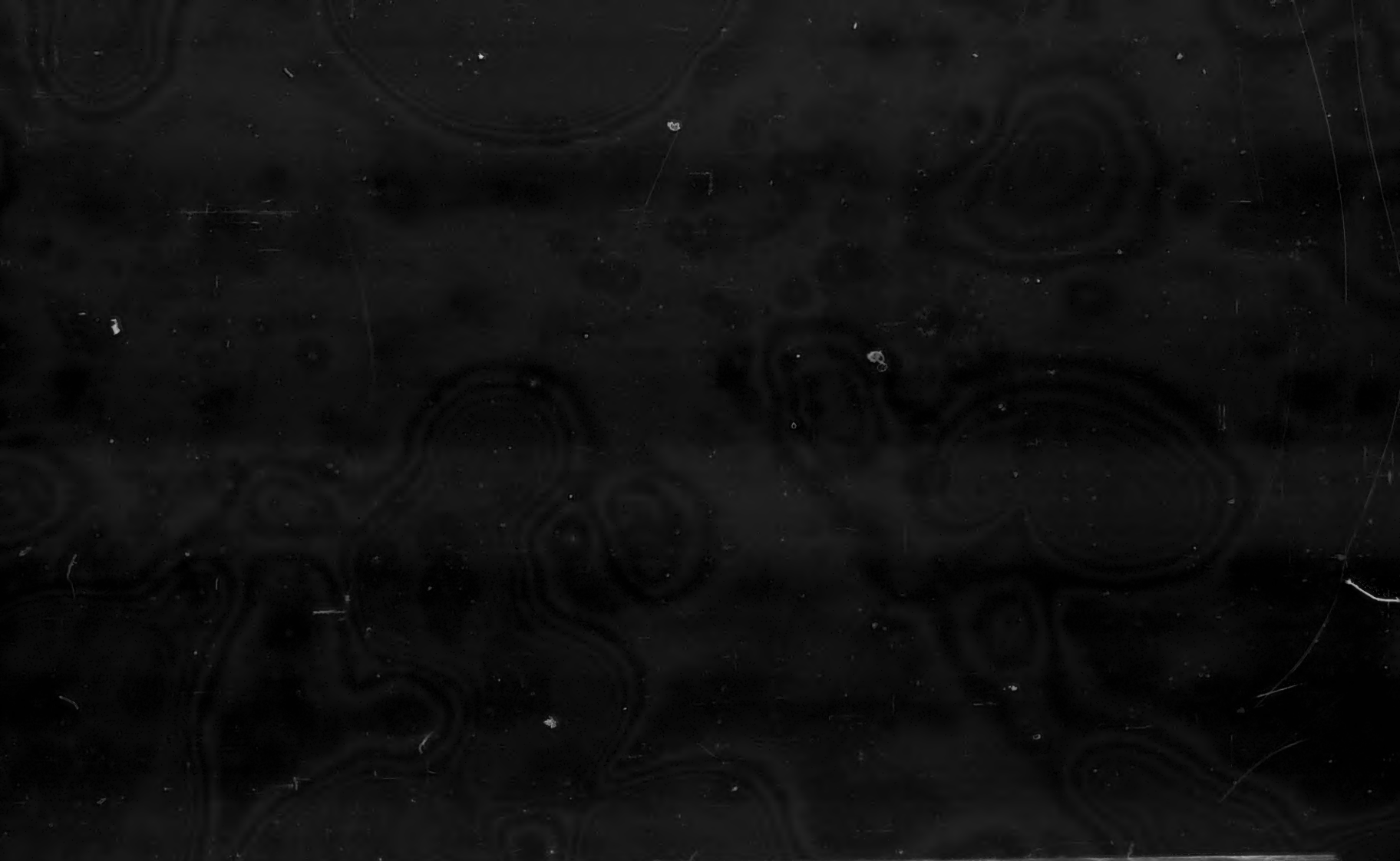

Canadian Journal of Research

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VOL. 26, SEC. D. DECEMBER, 1948 NUMBER 6

ON THE SPECIES OF THE GENUS *METABRONEMA* YORKE AND MAPLESTONE, 1926, PARASITIC IN TROUT AND CHAR[1]

BY L. P. E. CHOQUETTE[2]

Abstract

In this study of species of the genus *Metabronema* parasitic in trout and char the author is of the opinion that, on the basis of the characters of the postcloacal papillae and the spicules, the following species should be regarded as synonymous: *Metabronema* (= *Spiroptera*) *salvelini* Fujita, 1920, *Metabronema harwoodi* Chandler, 1931, *Metabronema canadense* Skinker, 1931, and *Metabronema truttae* Baylis, 1935. By virtue of the law of priority, *Metabronema salvelini* Fujita, 1920, must stand as the valid name of the species.

Three species of nematodes ascribed to the genus *Metabronema* Yorke and Maplestone, 1926, have been reported from fish in North America: *Metabronema canadense* described by Skinker (10), *M. harwoodi* described by Chandler (3), and *M. wardlei* described by Smedley (12). The first two species are parasitic in char (*Salvelinus fontinalis*), the third in a species of rockfish (*Scorpaenichthys marmoratus*). The form described by Chandler was first ascribed to the genus *Cystidicola* Fisher, 1798, but afterwards was transferred by Skinker (11) to the genus *Cystidicoloides*. Baylis, in 1933 (1), in his study of the genera *Cystidicola*, *Metabronema*, and *Cystidicoloides* concludes that the last two are synonymous. Therefore, the name of the species described by Chandler became *Metabronema harwoodi*.

Species of *Metabronema* have been reported from char and trout in other parts of the world. In Japan, Fujita in 1920 (Baylis (2)) described *Spiroptera salvelini* from *Salvelinus malma* and, in 1928, reported this species from *Salvelinus kundscha*. Baylis (2) placed this species in the genus *Metabronema*, and, in 1935, Yamaguti (14) amplified its morphological description as *Metabronema* (*Cysidicola*) *salvelini*. In 1928, Fujita (4) reported *Metabronema* (*Cystidicola*) *iwana* from *Salvelinus malma* and, in 1939 (5), three additional species from the char *Salvelinus kundscha*, namely *M. kosugii*, *M. amemasu*, and *M. ishii*. The latter species was described originally under the name of *Metabronema salvelini* but, the name being preoccupied, it was later changed by its author (6) to its present one.

[1] *Manuscript received July 13, 1948.*

Contribution from the Institute of Parasitology, McGill University, Macdonald College, Que., with financial assistance from the National Research Council of Canada.

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In Great Britain, Baylis (2) described *Metabronema truttae* from the brown trout, *Salmo trutta*. Baylis notes the great similarity existing between this species and *Metabronema* (*Spiroptera*) *salvelini* and *Metabronema canadense*. He even points out the fact that if all the measurements are taken into account, no clear distinction appears to exist between these forms. This is not the case with the species from the char as described by Fujita (4, 5), all of which possess morphological characters sufficient to distinguish them from *Metabronema salvelini*, *M. canadense*, and *M. truttae*.

During a recent survey of helminths parasitic in the speckled trout, *Salvelinus fontinalis*, in the lakes and rivers of the Laurentide Park, Quebec, a nematode ascribed to the genus *Metabronema* was found commonly in the digestive tract of the host. It was similar to *Metabronema canadense* as described by Skinker (10) from the same host. Since Skinker's description was incomplete, particularly in regard to the nature of the postanal papillae, because of the paucity of the material at her disposal, the opportunity is taken to add to the description of this species and to attempt to clarify its relationship with the others found in char and trout. As stated by Baylis (2) the evidence for the distinctiveness of *M. salvelini*, *M. canadense*, and *M. truttae* is very inconclusive; it rests mainly on morphological points such as the nature of the postcloacal papillae and the character of the spicules. These points were, therefore, given particular study in the specimens found by the writer.

The writer had the opportunity of studying part of Miss Skinker's material but it was, unfortunately, in such a condition as to make very difficult the task of securing a clear picture of the nature of the postanal papillae in the male, and could be studied only in lateral view. This study could only confirm the observations made by Mr. J. T. Lucker (8) of the Zoological Division of the U.S. Bureau of Animal Industry, Washington, D.C., namely, that there were five pairs of postcloacal stalked papillae; that is, one pair additional to the four shown by Skinker in her figure of the right side of the tail of the male. This additional pair is located in close proximity and median to the anterior-most of the postcloacal pair.

A ventral–dorsal view of the posterior extremity of male specimens, collected by the author, shows that there are five pairs of stalked postcloacal papillae and a sixth pair of very small papillae situated at the posterior extremity of the tail between the fifth pair (Fig. 1); it is doubtful whether they can be seen in lateral view. A sixth pair exists in *Metabronema truttae* as described and illustrated by Baylis (2). No mention of such papillae in *M. salvelini* appears in Fujita's description (Baylis (2)), nor Yamaguti's (14). In the arrangement of the first two pairs of postcloacal papillae there is a similarity between our material and *M. truttae* as described and illustrated by Baylis (2); it also resembles the arrangement described by Yamaguti (14) in respect to *M. salvelini* Fujita.

In his description of *M. truttae*, Baylis (2) states that the longer spicule is the left one while neither Fujita (Baylis (2)) nor Yamaguti (14) state whether the

longer spicule is that of the right or the left side. In *M. canadense*, according to Skinker (10), the right spicule is the longer one. This could not be determined with certainty in our study of Skinker's material. However, in the material at the writer's disposal the longer spicule, as is the case in *M. truttae* Baylis, is the left one (Fig. 1). Fujita (Baylis (2)) defines and illustrates

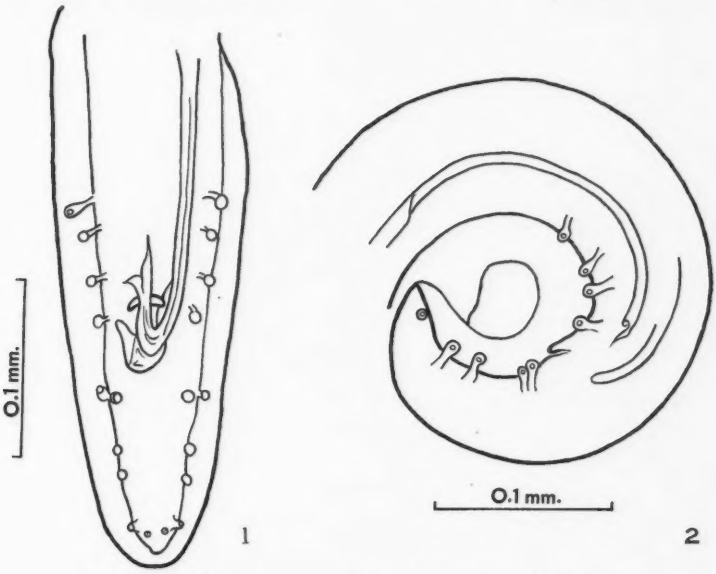

FIG. 1. *Metabronema canadense, adult male, ventral view.*
FIG. 2. *Metabronema canadense, adult male, lateral view.*

(4) a pair of transverse processes as the tip of the longer spicule. This is not reported by Yamaguti (14), and Baylis was unable to observe whether or not similar processes are to be found in the form of *Salmo trutta* because he did not have the opportunity of studying protruded spicules.

Processes on the longer spicules could be seen in ventrodorsal view of the posterior extremity of another male in mounted specimens (Fig. 1). However, the writer is of the opinion that this is not the real aspect of the extremity of the longer spicule, but that these "transverse processes" are due to distortion brought about by pressure. In lateral view it is seen that in its distal extremity the longer spicule is curved into a trough or gutter with the inferior wall of this gutter prolonged as a sharp point, while the superior one curves inward (Fig. 2), thus accentuating the groove. Therefore, when the spicule is protruded and bent on itself, as is often the case, and slight pressure is applied, so-called "transverse processes" are produced, as shown in Fig. 1. Skinker (10), in her figure of the right side of the tail of the male of *M. canadense*, shows partly the arrangement existing at the distal extremity of the longer spicule. This aspect of the spicule was observed also in her type material.

The aspect of the distal end of the spicule in lateral view is quite similar to that illustrated by Johnston and Mawson (7) in their study of *Ascarophis cooperi* from *Platycephalus bassensis*.

Lyster (9) reported the presence of *Metabronema* (*Cystidicoloides*) *harwoodi* in speckled trout from other parts of this Province. However, examination of Lyster's material shows it to be identical with *M. canadense*. This species was found also in material from a species of char (probably the Arctic char, *Salvelinus arcturus* Günther), from the coast of Labrador, and deposited at this Institute.

Van Cleave and Mueller (13) report the presence of *Metabronema* (= *Cystidicoloides*) *harwoodi* Chandler in *Salmo fario* from Oneida Lake. These authors, after study of Chandler's type material, conclude that this species is identical with *M. canadense* Skinker, this species being merely a smaller variety. In their redescription of *M. harwoodi*, these authors report the presence of five pairs of postanal papillae and discuss the shape of the longer spicule at its distal extremity. The writer had the opportunity of studying specimens kindly loaned by Prof. Chandler, as well as the type material of *M. harwoodi*, deposited in the helminthological collection of the United States National Museum. In both cases the specimens were found to exhibit the character used as criterion in this study of species of the genus *Metabronema* in char and trout, that is, the arrangement of the postanal papillae and the shape of the left spicule.

Conclusions

As the result of this study, the writer believes that, on the basis of the characters of the postcloacal papillae and the spicules the following species should be regarded as synonymous: *Metabronema* (= *Spiroptera*) *salvelini* Fujita, 1920, *Metabronema harwoodi* Chandler, 1931, *Metabronema canadense* Skinker, 1931, and *Metabronema truttae* Baylis, 1935. By virtue of the law of priority, *Metabronema salvelini* Fujita, 1920 must stand as the valid name of the species.

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The writer wishes to express his gratitude to Dr. E. W. Price of the United States Bureau of Animal Industry, who has kindly arranged for the study of type material and to Prof. A. C. Chandler, who has kindly loaned me specimens of *Metabronema harwoodi*. Thanks are due, also, to Mr. J. T. Lucker, of the United States Bureau of Animal Industry, whose co-operation has been of value in this study.

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A PRELIMINARY ACCOUNT OF THE BITING FLIES AT CHURCHILL, MANITOBA[1]

By C. R. Twinn,[2] B. Hocking,[3] Wm. C. McDuffie,[4] and H. F. Cross[5]

Abstract

The occurrence is recorded at Churchill, Manitoba, of 5 genera and 11 species of Culicidae, 2 genera and 12 species of Simuliidae (3 and possibly 4 of which may be new to science), and 2 genera and 10 species of Tabanidae. Data are presented on their habitats, life histories, habits, species association and succession, and relative abundance and distribution. Observations on the relationships of these insects to other organisms are recorded, including notes on their status as pests and their influence on human activities in the locality. Evidence is presented that female mosquitoes feed on the nectar of flowers and are efficient pollinators of northern orchids. A brief general picture of the ecology of the locality is given; also details of weather conditions during the period of the survey, and some microclimate data. Illustrations from photographs showing typical habitats of many of the species dealt with are included.

Introduction

The observations on which this paper is based were made during the course of a biting fly survey and experimental control program carried out at Churchill, Manitoba, during the spring and summer of 1947 as a joint project of the Division of Entomology, on behalf of the Canadian Defence Research Board, and the U.S. Bureau of Entomology and Plant Quarantine, on behalf of the Surgeon General, Department of the U.S. Army*. The results of the control investigations and repellent studies against the various species of biting flies are to be published elsewhere.

Churchill is situated at approximately latitude 59° N. and longitude 94° W., on the western shore of Hudson Bay, at the mouth of the Churchill River. It lies inside the subarctic area, about 170 miles from its northern boundary. Within a radius of a few miles is to be found a great variety of terrain, including spruce–larch forest, muskeg, tundra, tundra meadow, birch–willow scrub, low gravel and granite ridges, tidal flats, and sand dunes. It is a zone of transition from forest to tundra and supports a varied insect fauna including species of biting flies typical of the forest and the plain and of the subarctic and the arctic.

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* *Acknowledgment is made of valued assistance received from the following members of the joint party: Major J. B. Goldsmith, Sn.C., U.S. Army; C. N. Husman, U.S. Bureau of Entomology and Plant Quarantine, J. F. Sharp and R. W. Fisher, Division of Entomology, Dominion Department of Agriculture, Canada.*

The northern fringe of the vast subarctic forest extends to within a short distance of Churchill. In the Churchill region it is rather open and swampy and consists chiefly of spruce and larch (the tallest trees probably not exceeding 30 ft.) and dwarf shrublike willow and birch. The forest floor is for the most part soft and spongy underfoot, extremely tiring to walk on, and in many places treacherous to the unwary. It frequently has a variegated appearance owing to the different shades of gray, green, and brown of the deep mat of lichens, mosses, and grasses that cover it. The trunks and branches of the trees commonly bear patches and tufts of lichens, which increase the rather unkempt and melancholy appearance of the somber woods.

The tundra and tundra meadow in the area extends from the scrubby and scattered tree growth along the uneven margins of the forest to the shore of Hudson Bay. The predominant vegetation consists of lichens, mosses, and coarse grasses. Flowering plants abound, their successive blooming adding a touch of color and beauty to the bleak landscape. Where soil conditions are favorable, dwarf spruce grows in small clumps or singly. On exposed ridges overlooking Hudson Bay the branches of these stunted trees grow only on the south side of the slender trunks, giving them a forlorn, windswept appearance. In protected situations, such as along the borders of streams and on the swampy ground between the forest and the Churchill River, dwarf birch and willow grow, in places forming dense thickets.

Large numbers of birds nest and raise their young in the Churchill region and the marshes and swamps often resound with their calls. Common among them were ducks, geese, gulls, terns, sandpipers, plovers, curlews, snow buntings, and ptarmigan. Among them, too, was that familiar habitué of suburban gardens, the American robin. Mammals were much less in evidence. A few caribou were seen near the Churchill River; also porcupine were seen in the forest and a number of larch trees stripped of bark by their feeding. Local trappers stated that the woods south of Churchill provide good winter hunting of moose and caribou and trapping of mink and beaver. Burrows and trails of small rodents were numerous in the area, but their numbers were apparently at a low ebb in 1947, for the animals themselves were rarely seen and, in spite of several attempts to trap them, only three arctic mice (lemming) were captured. From these, two males and six females of the flea *Megabothris groenlandicus* Wahlgren were taken (det. G. P. Holland). Schools of white whales entered the mouth of the Churchill River after the ice went out (June 20) and numbers of these were harpooned and shot for their meat and oil by local Indians and trappers. Of fish, pike, grayling, and suckers abound in the larger streams and apparently serve as a major part of the diet of sled dogs during their enforced summer idleness. Specimens of two small species of fish taken in the streams were sent to the Royal Ontario Museum of Zoology, Toronto, Ont., and identified by W. B. Scott, of the Division of Fishes, as the capelin, *Mallotus villosus*, and the nine-spined stickleback, *Pungitius pungitius*. No reptiles were seen, but frogs were common in the marshes

and swamps, and specimens collected were identified by Clyde L. Patch, of the National Museum, Ottawa, as the northern wood frog, *Rana sylvatica cantabrigensis*.

Drainage is generally poor in the Churchill region because much of the terrain is low-lying and the ground is permanently frozen a short distance beneath the surface. As a result, innumerable shallow pools form on the tundra (Figs. 1 and 2) and in the forest during the spring thaw and serve as breeding places for the countless hordes of mosquitoes that appear on the wing in late June and July. What drainage there is occurs largely through numerous streams that flow into the Churchill River and the Hudson Bay. From these streams and the rapids of the river, vast numbers of blackflies emerge and, with the mosquitoes and the bloodsucking tabanids variously called bulldog, moose, and deer flies that develop in the forest, plague man and beast throughout the short summer.

The Weather

An analysis of daily weather summaries obtained from the Department of Transport meteorological officer at Churchill for the 87-day period (May 16 to Aug. 10) covered by this investigation, shows that the average temperature was 47° F., the averages for May (part), June, July, and August (part) being 24.5, 44.8, 58.3, and 54.3° F., respectively. The range of temperature was 73 Fahrenheit degrees, from a low of 9° F. on May 17, to a high of 84° F. on June 20 and July 12. The relative humidity was high throughout the period but particularly so before the thaw. The average figure for the whole period was 85.5%; that for May (part) 91.5%; and that for the remaining period, separately, 84%. The relative humidity figures had a range of 57% from a low of 43 on June 18, to 100% on several days; daily averages ranged from 63 on June 19, to 100%. No definite trends appear in the figures for barometric pressure.

Wind speed showed a slight general decrease from May to June and July, followed by an increase early in August. The average wind speed for the whole period was 12.6 m.p.h.; averages for each of the months separately were 14.3, 11.8, 11.9, and 14.7 m.p.h. respectively. The range of wind speed was from calm on May 18, July 13, July 16, and Aug. 3, to 45 m.p.h. on May 24, and 36 m.p.h. on Aug. 6. Apart from a scarcity of east and southeast winds, there was no marked trend in the frequency with which the wind blew from each direction, except that west and northwest winds were somewhat the more common.

The total precipitation during the period was 5.18 in., water equivalent, of which 0.08 in. was in the form of snow. This precipitation was distributed between the four months as follows: 0.18, 0.91, 0.95, and 2.90 in., the maximum rainfall on any one day being 1.63 in. on Aug. 5. There was measurable precipitation on 36 of the 87 days: on 7 of the 16 days in May, 10 days in June, 12 days in July, and 7 of the 10 days in August.

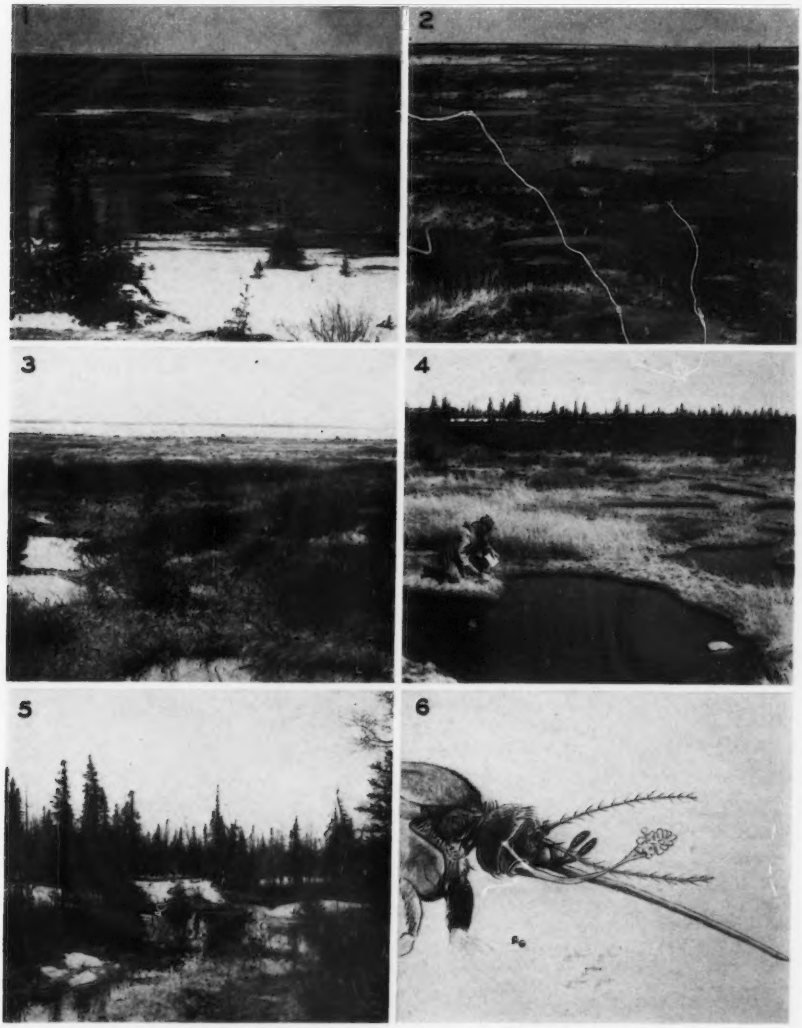

FIG. 1. *Mosquito infested pools on tundra in early June.* FIG. 2. *Snowpools on tundra meadow, breeding place of A. nigripes and A. punctor.* FIG. 3. *Beach Bay area east of Churchill River, breeding place of several species of Aedes.* FIG. 4. *Pools near Beech Bay, breeding place of A. nearcticus and A. campestris.* FIG. 5. *Forest snow pools in which newly hatched larvae of A. communis and A. punctor appeared on June 9.* FIG. 6. *Pollinium of the northern orchid, Habenaria obtusata, attached to the compound eye of A. nigripes.*

FIG. 7. *Railway drainage channel, breeding place of S. venustum.* FIG. 8. *Larvae of S. venustum photographed on stones under water.* FIG. 9. *Lesions on neck caused by bites of S. venustum.* FIG. 10. *Small stream or rill where larvae and pupae of E. latipes were found.* FIG. 11. *Mideastern Creek near source on tundra, breeding place of Eusimulium and Simulium species.* FIG. 12. *Tabanids (H. affinis) in flight around a stationary vehicle.*

Observations of cloud conditions during the hours of daylight may be summarized as follows: 53% overcast, 40% partly cloudy, 7% clear.

The ice went out of the Churchill River on June 20, the expected date for this occurrence being that of the spring tides closest to June 15. The season at this stage was nearly a week later than normal. A comparison of average temperatures for June and July, 1947, with similar averages obtained over a number of years supports the impression received from residents that by the end of July the season was normally advanced.

The Mosquitoes (Culicidae)

The Species Present

Eight species of *Aedes* and two species of *Culiseta* have been identified among the specimens collected or reared in the Churchill area during 1947. No other genus of the subfamily Culicinae was represented, but the predaceous larvae of three genera of nonbiting mosquitoes of the subfamily Chaoborinae, namely, *Eucorethra*, *Mochlonyx*, and *Chaoborus*, were fairly common in the culicine breeding pools. Unfortunately, none were reared to the adult stage, but a male and female collected from a mating swarm at 4 p.m. on July 24 belonged to the species *Chaoborus nyblaei* Zett.

The two species of *Culiseta* represented are *C. alaskaensis* Ludl., and *C. impatiens* Wlk. They are not abundant in the area, only small numbers of overwintered females being seen or captured during the month of June. No males or aquatic stages of the species were found.

The species of *Aedes* definitely determined include *A. nigripes* Zett., *A. punctor* Kby., *A. nearcticus* Dyar, and *A. communis* Deg., occurring probably in that order of abundance; *A. campestris* D. & K. and *A. excrucians* Wlk., less abundant, but numerous and widespread; *A. flavescens* Müll., and *A. cinereus* Mgn., apparently relatively few and localized in occurrence. From the examination of numerous females in the temporary field laboratory at Churchill, it was believed that several other species of *Aedes* were present in the region, but it was not possible to substantiate this in the absence of males, or the definite association of reared females with the last larval molt.

Dr. Alan Stone, of the Division of Insect Identification, of the U.S. Bureau of Entomology and Plant Quarantine, Washington, D.C., who kindly examined the doubtful specimens, stated, "I do not feel confident of determining any of your undetermined female *Aedes*. There is just too much similarity and at the same time too much variation within species to permit it, I think." Later, he further commented (*in litt.* Jan. 12, 1948) "As for the females, the more I look at them the less sure I am that they can be determined with any degree of accuracy. I tried to sort them out, but I was so uncertain that I

finally gave up. I think it quite probable that you have no other dark-legged species than these four (*nigripes*, *nearcticus*, *punctor*, and *communis*), with the possible exception of one specimen that looked very much like *pullatus*. I am quite certain that neither *aurifer* nor *intrudens* were present; *cataphylla* may be present, but I very much doubt it. Since *pionips* does not appear to be separable from *communis* in either the female or the male genitalia, it is possible that this species is included in those which I have determined as *communis*. It would be necessary to see larvae to settle this point." Incidentally, it is worth noting that there is no clear indication of the difficulty or impossibility of determining these and certain other black-legged northern species in Matheson's key (8) for the identification of North American *Aedes* females.

Seasonal Development

All the species of *Aedes* found in the Churchill area overwinter in the egg stage. Larvae began to hatch in small numbers in snowpools in sheltered places on the tundra at the beginning of June, when snow and ice were still prevalent in the area. By the middle of June, when the snow was largely gone from the tundra, the larval population of several abundant species was nearing its peak in pools in the open and among the sparse tree growth along the margins of the forest. These species were *A. nigripes*, *A. punctor*, and *A. nearcticus*. Immature larvae of *A. excrucians* had also begun to appear. In the forest the first larvae of *A. communis* were found hatching in favored snowpools on June 9, when nearly two-thirds of the forest floor was still covered with fast-melting snow.

Pupation of *A. nigripes* began on June 16, and *A. punctor* on June 17, the first adults emerging on June 20 and June 21, respectively. Emergence of *A. nearcticus* started on June 22, and that of *A. communis* in the forest on June 24. Periodical collections indicate that these four dark-legged species are the dominant ones in the Churchill region.

Towards the end of June emergence was general. During the early part of July pupae were still common, but larvae were becoming increasingly hard to find. By July 3, tremendous numbers of mosquitoes were on the wing and they continued to increase until a peak of abundance was reached during the second week of July. The pest species were augmented by adults of *A. campestris* on July 5, *A. excrucians* on July 9, *A. cinereus* on July 13, and *A. flavescens* on July 20. By the third week of July, however, a definite falling off in abundance and aggressiveness of the general mosquito population was apparent. This is reflected in the daily average number of bites per minute on exposed untreated forearms (elbow to wrist) and legs (knee to ankle) recorded during 100 check tests carried out at several points in the area, July 6 to 17, in connection with field studies of repellents (Fig. 13).

After the third week in July the decline in mosquito abundance was progressively more marked, until in early August, when observations ceased, their numbers had reached comparatively small proportions.

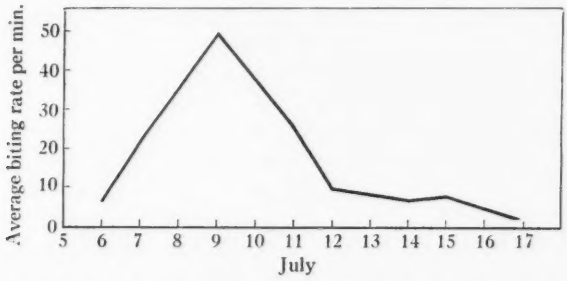

FIG. 13. *Graph showing average number of mosquito bites per minute on forearms and legs in 100 check tests, Churchill, July 6 to 17, 1947.*

NOTES ON THE SPECIES

Aedes nigripes Zetterstedt

This rather large, hairy, dark-colored species is the most abundant mosquito in the Churchill region beyond the forest.

Larvae began to hatch in shallow, grassy, snow water pools on tundra meadow (Figs. 1 and 2) early in June. Small numbers of first, and fewer early second, instar larvae were found on June 4. The water in these pools was 52° to 64° F., but was probably lower at night, some of the pools having a thin sheet of ice on them in the morning, before the sun was high.

By June 11, when the snow had largely disappeared from the open tundra except for occasional dwindling drifts, newly hatched larvae were still appearing, but second instar larvae predominated and many had molted into the third stage. The general infestation in the innumerable pools across the marshy tundra and among the scattered trees along the margins of the swampy forest ranged from sparse to moderate: in some there were none; in others one to several larvae per square foot; in still others several to many per dip.

Fourth instar (last stage) larvae of *A. nigripes* began to appear in sheltered pools on June 13, associated with lesser numbers of *A. punctor*. The first pupae were found on June 16, in shallow pools on rough meadow supporting a sparse scattered growth of stunted spruce and larch. The temperature of the water was 73° F. Immature larvae were still plentiful in some pools.

A typical breeding area of *A. nigripes* is near Beech Bay, east of the Churchill River, consisting of several square miles of shallow pools among marsh grasses and dwarf willow and birch (Fig. 3). In addition to *A. nigripes*, larvae of *A. nearcticus*, *A. excrucians*, and *A. campestris* developed in this area. When examined on June 18, the numerous larvae ranged from first to fourth instar, probably second and third predominating. The smallest larvae may have been *A. campestris*.

June 20 was one of the warmest days of the summer, the shade temperature reaching 84° F. Pupae were becoming increasingly common in the breeding areas. By 9 a.m. several males of *A. nigripes* emerged in the laboratory and emergence had undoubtedly started in the field. The next day (June 21) parties working at various points in the area reported that mosquitoes were on the wing and beginning to be troublesome. Specimens collected were *A. nigripes*, *A. nearcticus*, and *A. punctor*. On June 26, the pools in the Beech Bay area were still infested with larvae and pupae. The heaviest infestation appeared to be in the transition zone between grass and dwarf willow and birch, consisting almost entirely of fourth instar larvae, but some pupae. Higher up in the shrub zone the infestation was at least 50% pupae. Larvae collected were 86% *A. nigripes*, the remainder being *A. excrucians* and *A. campestris*. Emergence of adults of *A. nigripes* was increasingly general throughout the area during the last 10 days of June and was probably largely completed in the first week of July, the last recorded emergence being on July 4.

By July 3, mosquitoes (*A. nigripes*, *A. nearcticus*, and *A. punctor*) were present in tremendous numbers and continued to increase for some days thereafter. *Aedes nigripes* is a strong flier and probably a migratory species, although its flight range has not been determined. This statement also applies to *A. nearcticus*. On the night of July 2–3 there was a strong south-southeast wind and for the first time the insects were numerous in the military camp and below the ridge overlooking Hudson Bay, and many persons donned headnets and there was a sudden call for repellents. Outside the camp, in the sparse woods and on the tundra they occurred in enormous numbers and with a sharpened blood lust. Even on the granite and gravel ridge exposed to a strong cool wind they beat at one in clouds, with darting, dancing flight, getting into mouths, ears, and nostrils and up trouser legs and into pockets, biting at every opportunity, wherever the skin was unprotected by clothing or repellent.

At 1.15 p.m. on July 3, several mating swarms were seen over the tundra between a narrow belt oi scrubby spruce and the camp buildings. They occurred in small darting, dancing clouds around the perimeter of a small, shallow lake, the swarms extending about three to nine feet above the ground. A midget net swept several times through two of these swarms caught a couple of dozen males and several females, all *A. nigripes*.

On July 6 two observers walked several miles east of the camp along the rocky Hudson Bay coast line, skirting the granite ridge to the marshy tundra meadow beyond, to examine blackfly streams. In spite of a fresh northeast breeze and bright sunshine, mosquitoes were abundant everywhere, although less numerous on the sandy beach by the sea away from cover of any sort. Among large rocks and boulders, however, they were as troublesome as inland on the tundra. They even sheltered in collections of seaweed left high by the retreating tide. They were persistent in attack, flying against the wind.

A mixture of equal parts of dimethyl phthalate and ethyl hexanediol (Rutgers 612) applied to the skin had to be renewed at less than hourly intervals. The insects alighted in large numbers on hats and clothing. Khaki woollen shirts gave only partial protection and it was found necessary to apply repellent freely to the cloth by hand. The mosquitoes readily found untreated places and collected there in clusters, biting freely where the cloth was in contact with the skin. Specimens collected indicated *A. nigripes* to be the dominant species in these open places but *A. nearcticus* was present, and probably also *punctor*.

On July 9, a visit was made by assault boat to several points along the west bank of the Churchill River from opposite Churchill to Mosquito Point. The weather was misty, humid, and moderately warm, the wind light, and mosquitoes were on the wing in enormous numbers. The terrain here consists of marshy ground with patches of dwarf willow, gently sloping upwards to a granite ridge. Many of the mosquitoes were largely denuded of scales on the mesonotum, but a careful examination of the more perfect specimens indicated that *A. nigripes* was most numerous, with *A. nearcticus* and *A. punctor* also present. They continually beat at one, sometimes sounding like rain against the parka jackets. Blackflies (*Simulium vittatum* Zett.) were discerned among the swarming mosquitoes. Repellent 6–2–2 smeared liberally on all exposed areas of skin generally prevented biting, but the applications had to be renewed every half hour or so. Elsewhere in the area biting rates of up to 120 per minute, with an average of 50, on exposed, untreated forearms, or legs from knee to ankle, were recorded by investigators making field tests of repellents.

A. nigripes had probably reached or passed its peak this day. After the middle of July there was a marked decline in the abundance and aggressiveness of this and other black-legged species of *Aedes* in the area, but they persisted in diminishing numbers into August.

There are few definite records of the distribution of *A. nigripes*, but, with *A. nearcticus*, it is probably widespread throughout arctic Canada. It was first collected, as larvae, from a pond at Bernard Harbour, N.W.T. (north of the Arctic Circle) on June 28, 1915, by Fritz Johansen and described as *Aedes* n. sp. by Dyar (2). In 1925, as recorded by Twinn (14), J. D. Soper collected males, females, and larvae east of Nettilling Lake, Baffin Island (near the Arctic Circle), the larvae being taken on June 28, and the adults on June 30, July 9, 17, and 22. According to Twinn: "During his sojourn in Baffin Land, Mr. Soper states that mosquitoes were not very troublesome, and it was never necessary to wear a veil as a protection against their bites. He found larvae common in shallow pools in the latter part of June, the adults making their appearance at the end of June, and becoming most numerous in late July and early August, apparently reaching the peak of their abundance on August 7." In 1947, T. N. Freeman collected females of *A. nigripes* at Baker Lake, N.W.T. in the latter part of July and a male on Aug. 1.

Aedes nearcticus Dyar

This species is closely allied to *A. nigripes* and hard to distinguish from it in the adult form. For this reason it is rather difficult to evaluate its status as a pest in the Churchill area on the basis of the 1947 data, especially as males were reared from larvae collected in only three areas, all treeless, and including the marshy tundra just east of the Churchill River at Beech Bay (Fig. 4), tundra meadow pools, and grassy pools on the granite ridge between Churchill and the camp. These reared males, eight in all, emerged June 22 to 26, indicating that the life history of the species is similar to that of *A. nigripes*.

Numerous females collected and identified as *A. nearcticus* by means of Gjullin's key (3) indicate the species to be an abundant one in the region, although this was not revealed in a study of collections of larvae taken from various breeding places in the area. Like *A. nigripes*, this species is believed to be a strongly migratory one, and the infestation may have originated largely from breeding places outside the surveyed area. The distribution of *A. nearcticus* is not well known. It is probably widespread in the Canadian arctic, and it occurs at high elevations farther south.

Dyar (2) described *A. nearcticus* from specimens reared by Fritz Johansen at Bernard Harbour, N.W.T. in July 1915. He also identified as apparently the same species, females collected by Johansen at Young Point, Cockburn Point, and Cape Bathurst, N.W.T. and Herschel Island, Y.T.

Hearle (4) reported localized breeding of *A. nearcticus* at high altitudes in the Rocky Mountains in Alberta. Localities mentioned include Lake Louise in 1921, Simpson's Summit (about 7000 ft.) in 1922, and the Cascade Mt. amphitheater in 1924 and 1925. In the Cascade Mt. area in 1925 Hearle noted that pupation was general by June 18 and the adults began emerging by June 22, which is similar to the seasonal development observed at Churchill (at less than 75 ft. above sea level) in 1947.

Aedes punctor Kirby

Like *A. communis*, this species is difficult to separate in the female form from the other black-legged *Aedes* (except *A. cinereus*) in this region. It is an abundant pest in the Churchill area, fiercely attacking man and beast in the forest with *A. communis*, and over the tundra with *A. nigripes* and *A. nearcticus*.

The larvae of *A. punctor* were most commonly found associated with those of *A. nigripes* and less frequently with *A. communis* and *A. excrucians* in pools and marshy areas sparsely grown with scrubby spruce and larch; with *A. nigripes* on treeless open tundra meadow beyond but near the tree line, and with *A. communis* in the swampy woods (Fig. 5).

The earliest *A. punctor* larvae began hatching in favored grass-bottomed snow water pools beyond the forest in the first week in June, and in the forest on June 9. First stage larvae collected from a tundra meadow pool on June 6 and from a forest pool on June 9 and reared in the laboratory produced both sexes of adults on June 29.

In the field, mature larvae were numerous by June 14 in grassy pools in the open, and among or near sparse tree growth and in open places in the forest. The earliest pupae appeared on June 17, and the first adults (identified by the male genitalia) were on the wing on June 21. Mature larvae could be found up to the end of June, and emergence of adults from specimens taken to the laboratory continued up to July 7, by which date the general mosquito population was reaching its peak.

Males of *A. punctor* were collected swarming a few feet above the Hudson Bay Railway tracks, in the forest near Warkworth Creek, after sunset (10.30 p.m.) on July 13. They were also collected swarming over the tundra near woods east of Churchill, at 4 a.m. (about 10 min. after sunrise) on July 25.

The species is widely distributed in Canada from Prince Edward Island to British Columbia. The most northerly record for Canada so far obtained is Baker Lake, N.W.T., where eight males were collected by T. N. Freeman, July 14 and 23 and Aug. 2 and 13, 1947 (det. G. E. Shewell). According to Hearle (6) it does not fly far from its breeding places.

Aedes communis DeGeer

This black-legged forest species is very similar in appearance to *A. punctor* Kby., from which it is probably distinguishable with certainty only in the larval form or by the male genitalia. *A. communis* and *A. punctor* appear to be the dominant mosquitoes throughout the vast swampy coniferous forest south of Churchill.

First stage larvae were found in shallow snow water pools in the open forest (Fig. 5) several miles south of the tree line, on June 9. On this day nearly two-thirds of the forest floor was still snow-covered (to a depth of 2 to 3 ft. in places), lakes were frozen, and most of the numerous pools and ponds formed by melting snow had snow or ice in them or at the margins. It was apparent that hatching of the overwintered eggs was not general as larvae could be found only in occasional favored pools in sunlit places sheltered from the wind. The temperature of one small pool heavily infested with newly hatched larvae was 48° F.

Three days later, on June 12, after a spell of comparatively warm weather another visit 12 miles south in the forest was made by snowmobile down the tractor trail to Warkworth Creek. By this time more than two-thirds of the forest floor was free from snow, the area was much wetter, and the rough trail was flooded with several inches of water in many places. At several points examinations were made of water bodies on or near the trail. Where coarse grasses were prevalent mosquito larvae in the first and second instars were few to very abundant, several scores being picked up in a single dip. The temperature of the infested pools was generally 50° F. or more. In colder waters the larvae had not yet appeared; nor were any found where the bottom consisted largely of sphagnum and other mosses.

Other activities prevented a further visit to this area until June 24, a cold, wet day, when some of the grassy pools contained innumerable pupae, and larvae and pupae were also found in moss-bottomed pools uninfested on previous visits.

Emergence of adults from material collected in those forest pools commenced in the laboratory the same day (June 24), 31 males and 15 females of *A. communis* emerging between that date and June 29. Other larvae of this species taken from pools in the swampy forest just south of Churchill, and from patches of scrubby spruce–larch woods east and west of the military camp gave rise to 14 males between July 4 and 7.

Unfortunately, it is difficult to identify with certainty the females taken in nature, but the prevalence and abundance of the larvae of *A. communis* indicate that this species formed an important part of the immense numbers of mosquitoes that were an almost intolerable pest to man and beast in and near the forest about Churchill in late June and July. Although it is a great pest in the forest, biting freely at almost any time of the day when its haunts are invaded, but especially after sunset, it is unlikely that *A. communis* flies far from the shelter of woods, or is a pest on the tundra at points distant from the tree line.

Wesenberg-Lund (16) studied the biology of this species in Denmark. He states:

> "In the vast forests of North-Seeland I have observed how the swarms in May are restricted to the very ponds in which they are hatched; but later on, especially in the middle of June, the swarms are fused together and, everywhere in the forest, horses as well as man are attacked. As an exclusive forest species it hardly ever goes out of the forest; according to my experience, the attack is always worst in the biggest and darkest part; here in the deep shade the attack on a sunny day at noon is just as severe as in the evening."

A. communis occurs in forested regions across Canada.

Aedes campestris Dyar and Knab

Compared with the abundant, rather drab, black-legged mosquitoes in the Churchill area, this is an attractively marked species, predominantly yellow and brown in color, with wings evenly mottled with dark and pale scales.

It is a rather late appearing species, larvae being first collected on June 26 in shallow, open pools in the marshy meadows in the Beech Bay area, east of the Churchill River (Fig. 4). From these several males emerged in the laboratory on July 5, and a female on July 6. On July 8, a warm sultry day, southward from Churchill to Warkworth Creek, along the railroad track, females of *A. campestris* were observed and specimens collected among the innumerable mosquitoes attempting to bite.

This species was a conspicuous one in open places, especially along the railway track in the vicinity of the camp site at Warkworth Creek, July 13 to 15, in sparse, swampy coniferous forest. It is believed that the source of these mosquitoes was the marshy tundra meadows a short distance to the west, between the river and the forest. The females of *campestris* attack at all times of the day from early morning until well after sunset. The times of day noted between July 13 and July 26 when collections were made of specimens, biting or on the wing, included 4.30 a.m., 11 a.m., 4 p.m., 7 p.m., 9 p.m., and 10 p.m. Specimens with the appearance of having recently emerged were noted as numerous and troublesome in Churchill military camp during the latter part of July, especially towards evening and after sundown, often invading the living quarters to bite. The insects were still common in the open country surrounding the camp in the early part of August when observations ceased.

Matheson (8) notes that *A. campestris* has been "recorded from Michigan west through the northern plains states to Utah, north to Alaska, and east to Hudson Bay." Rees (11) records that, in Utah, the species has been found to have a flight range of 10 miles from its breeding places.

Aedes excrucians Walker

This is a rather large mosquito with uniformly dark scaled wings and the tarsal segments ringed with white, broadly so on the hind legs.

It is a moderately common species at Churchill. The larvae were found in shallow grassy pools in sparsely wooded areas, in the open swampy forest and on the open tundra meadow, appearing somewhat later than the dominant black-legged species. They were found, usually in small numbers, in various locations associated with larvae of *A. nigripes*, *A. nearcticus*, *A. campestris*, *A. punctor*, and *A. communis*.

The larvae were first identified in the third instar on June 14. Mature larvae were collected on June 21, and specimens could still be found up to July 5. Adults were not taken on the wing until July 9, but became increasingly common after that date, persisting in moderate numbers into August. *A. excrucians* females are vigorous biters and may be active day and night, but especially in the evening and early morning. Recorded times of captures at Churchill were 1 a.m., 2. a.m., 6 a.m., 11 a.m., 3 p.m., 4 p.m., 6 p.m., and 7 p.m. According to Hearle (6) they do not fly far.

The species has a wide distribution in Canada, south of the tree line.

Aedes cinereus Meigen

A. cinereus is a small, dark mosquito, the smallest in the Churchill fauna. The larvae were not found, but the species is known to favor shallow forest pools. Females were collected in numbers July 13 to 25, chiefly in the swampy coniferous forest south of Churchill, but also on the tundra east of Churchill, near woods. They were found most numerous near Warkworth Creek at a temporary camp site in the woods, and were recorded biting in or near forest

cover from 9 a.m. to 8 p.m. Those taken in mid-July were in excellent condition as if newly emerged. The adults are reported to stay close to their breeding places. The species is widely distributed in Canada.

Aedes flavescens Müller

A large, yellowish species, with white banded tarsi, *Aedes flavescens* is a late appearing mosquito, individually conspicuous, but of comparatively minor importance at Churchill.

The first females were taken in the lakes and tundra meadow area west of the camp on July 20, about a month after the first appearance of *A. nigripes*. The next day they were observed in fairly large numbers in the open country bordering the Churchill River, together with *A. campestris* and other species They occurred in moderate numbers throughout the remainder of July and until observations ceased in early August, specimens being collected almost daily and always in the open, in and about the camp area and westward to the river. Most of the specimens were females but three males were taken in the Beech Bay area on July 21 and Aug. 2.

This species occurs widely in northern parts of the Nearctic and Palaearctic regions. Its biology has been studied in Canada by Hearle (5) and in Denmark by Wesenberg-Lund (16). The former noted that its main range in North America is in the Great Plains and that it is the second commonest species in the Canadian prairies where it breeds in large semipermanent, moderately deep pools containing much vegetation. In Denmark, Wesenberg-Lund indicated its habitat to be open meadows bordering on lakes and seashores. Both authors reported that although it readily attacks man it prefers larger animals, and when numerous is a serious pest of livestock. It has only one generation annually. The females, which may live for several weeks, are active by day, but especially at dusk. Hearle found that blood meals are essential to the development of the ovaries. The species is believed not to fly far from its breeding places.

Genus Culiseta Felt

Two species of this genus were found to occur sparsely in the Churchill area, namely, *C. alaskaensis* Ludlow and *C. impatiens* Walker. They appear to be too few and too timid in attack to be of importance as pests in this region.

Culiseta alaskaensis Ludlow

This is the largest mosquito in the region and is easily recognized by its size, its spotted wings, and the broad basal white bands on the tarsi.

Females of this species were first seen in the early evening (6.30 to 7 p.m.) on June 5 (a sunny day) flying in and about the officers' quarters, and two were captured. This was about two weeks before the earliest *Aedes* adults appeared. Occasional females were seen, or collected attempting to bite, in the swampy forest south of Churchill between June 9 and June 27, always

during periods of sunshine and, on two occasions (June 9 and June 12), when the air temperature was at or below 50° F., snow was still prevalent in the woods, and ice and snow persisted in forest pools and ponds (Fig. 5). Undoubtedly these insects had hibernated in sheltered situations through the long winter. An indication of the sort of places where *Culiseta* females hibernate is given in Peter Fidler's Journal for Apr. 4, 1792 (as quoted by Dr. Douglas Leechman, National Museum, Ottawa). The entry, which reads as follows, was made near Fort Fitzgerald, northwest of Lake Athabaska, just south of the northern boundary of Alberta:

> "Put up about ½ mile above the head of the rapids amongst a deal of old Large Poplars we made a good fire & soon after we were all very much surprised to see numbers of Muskettoes flying about altho the Snow was more than 10 Inches deep on the ground every where on examination we found that betwixt the Bark of the Poplars & the tree, of the old Dry wood there was a large open space which was full of muskettoes that have been in that situation all winter in some places they was in large cakes of 2 Inches thick the heat of the fire had invigorated them so as to be able to fly about in the manner before mentioned".

Little is known of the life history of *C. alaskaensis*. No adults were seen after the end of June and no aquatic stages were found. The eggs are reported to be deposited in rafts on the surface of water. An unsuccessful attempt to obtain eggs for rearing was made on June 17 by placing several captured females in a large cage containing a tray of water and split soaked raisins. They survived only two or three days without ovipositing. One of them that was induced to take a blood meal at noon on June 18 fed to repletion in two and one-half minutes.

According to Matheson (8) the previously recorded distribution of *C. alaskaensis* in North America was from Alaska to Colorado, the species occurring in the higher mountain ranges in the southern part of its range.

Culiseta impatiens Walker

This is a medium sized species, with black tarsi and less distinct spots on the wings than *C. alaskaensis*. Apparently it has similar habits. Two females were collected in bright sunshine in open spruce–larch woods just south of Churchill, on June 17, one while attacking a dog. It is reported to occur throughout the northern part of North America.

Mosquito Activity Around the Clock

Two observers made hourly collections of biting flies during a 24-hr. period on July 24–25 at two sites, one on tundra meadow and the other in nearby woods at a point seven miles east of Churchill Camp and about a mile from the Hudson Bay shore. The bulk of the mosquitoes collected were dark-legged species mostly too denuded for accurate determination, but probably including *A. nigripes*, *A. nearcticus*, and *A. punctor*. Small numbers of *A. campestris*, *A. excrucians*, and *A. cinereus* were also present.

The dark-legged species were on the wing throughout the 24-hr. period, but were most numerous between sunset and sunrise (10.55 p.m. and 3.50 a.m.) especially in the woods. During this period there was little or no wind and the lowest temperature recorded was 54° F. Males of *A. punctor* were observed swarming shortly after sunrise. *A. excrucians*, too, was collected at dark as well as in daylight. *A. campestris* and *A. cinereus* were collected during the hours before 9 p.m. and after sunrise.

Mosquitoes as Pollinators

On July 9, on the west bank of the Churchill River, some specimens in the attacking swarms of females of *A. nigripes* were noticed bearing one, and occasionally two, bright yellow stalked bodies attached by an adhesive disc to the ventral margin of the compound eyes (Fig. 6). Later these bodies were found adhering to the eyes of females of several other species of mosquitoes in the Churchill area, including *A. excrucians*, *A. punctor*, and *A. cinereus*. Of female specimens taken at hourly intervals on a 24-hr. collecting trip, on July 24–25, the percentage bearing them ranged from 2 to 33%, the average for the total collections being 6%.

At first these bodies were presumed to be a form of fungus, although they interfered not at all with the blood lust of the insects bearing them. Specimens were sent for identification to specialists in Canada and the United States and caused them considerable puzzlement. Eventually some of the specimens reached Prof. E. B. Mains at the University of Michigan, and Prof. T. Petch, King's Lynn, England, both of whom indicated them to be pollinia of a species of orchid*. The latter reported (in part) ". . . yours are the typical structure of an orchid pollinium—an adhesive disc, a stalk of varying length, and pollen masses at the apex."

The matter was then brought to the attention of Mr. A. E. Porsild, Chief Botanist, National Museum of Canada, who stated that the pollinia were from the northern orchid, *Habenaria obtusata*. He had first observed them on mosquitoes when he was camped on the north shore of Bear Lake, in July, 1928. He further noted that "*Habenaria obtusata* is the most common of the northern orchids and grows in open forests from Newfoundland to Alaska. On Bear Lake and elsewhere I have noted that, during its flowering period, as many as 5 per cent of mosquitoes on my tent carried one or two pollinia on their heads. Several species of orchids are equipped with pollinia that, upon the slightest touch, spring forward and by their sticky, disc-like base attach themselves to the head of an insect."

Mr. Porsild pointed out that this phenomenon had already been recorded by Raup (10). The latter observed the pollinia on the heads of mosquitoes in the Athabaska – Great Slave Lake region, and stated: "It is possible that the great abundance of the orchids (*H. obtusata*) is due to an efficient pollinization carried on by the myriads of mosquitoes which inhabit the woods."

* *Grateful thanks are extended to Prof. E. A. Steinhaus of the University of California for assistance in obtaining the identification.*

McClure (9) has recorded three species of *Habenaria* at Churchill, namely, *H. obtusata* and *H. hyperborea* in forested or bush areas, and *Habenaria* sp. in the bush and on high and mixed tundra.

The Blackflies (Simuliidae)

The Species Present

In the Churchill area blackflies breed in great numbers in the small streams that flow into the Churchill River and into Hudson Bay. They also develop in great abundance in the rapids of Warkworth Creek, south of Churchill, and the Churchill River itself. The difficult nature of the terrain, limited transport facilities, and the preoccupation of personnel with other projects permitted only an incomplete study of this group of insects.

Some years prior to the 1947 survey, one of the authors (Twinn) examined and identified collections of blackflies taken at Churchill in 1934, by A. M. Heydweiller, and in 1936 by H. E. McClure.

Heydweiller's collection, all females except where otherwise indicated, included six species that are listed as follows, together with a statement of the numbers of specimens and the period during which they were collected:

Simulium venustum Say, 121, July 11 to Aug. 30
Simulium vittatum Zett., 34 (plus four males) July 8 to Aug. 14
Simulium ottawaense Twinn, 26, July 10 to Aug. 15
Simulium arcticum Mall. 4, July 30
Simulium perissum D. & S., 4, July 30 and Aug. 11
Eusimulium baffinense palens Twinn, 2, July 30

McClure's collection was made up of many hundreds of female specimens, mostly *S. venustum* and *S. vittatum*, but also including four specimens each of *S. arcticum* (July 11 to 23) and *E. subexcisum* Edw. (July 11).

Thus these two collections were comprised of seven species. Among the specimens collected or reared during 1947, eight species are represented, five of them being additional to those collected by Heydweiller and McClure, making a total of 12 species found in the Churchill region. It is probable that other species will be discovered when further studies are made. The eight species taken in 1947 are as follows:

Simulium venustum Say
Simulium vittatum Zett.
Simulium sp.
Eusimulium aureum Fries
Eusimulium latipes Mgn.
Eusimulium species A
Eusimulium species B
Eusimulium species C

Notes on the Species Taken in 1947

Simulium venustum Say

This species is the most abundant of the blackflies in the Churchill area and the most important pest of man. The immature stages were found in all bodies of running water examined wherever blackflies were developing, including drainage ditches (Fig. 7), rills (Fig. 10), larger streams (Fig. 11), and rivers.

The first pupae were discovered on July 3, in a small stream in the camp area and adults began emerging on July 5. Observations on several other streams indicated that emergence was general in the area on this and subsequent days. Females were first captured attacking humans on July 8, by which date mosquitoes were reaching their peak. By mid-July, the numbers of blackflies of this species were tremendous, especially in wooded areas, and the streams contained heavy infestations of eggs, larvae (Fig. 8), and pupae, a condition that persisted until early August, when observations ceased.

In the latitude of Ottawa, *S. venustum* passes the winter in the larval stage (15) but in the Churchill region it is believed to overwinter in the egg stage, except possibly in the Churchill River, which continues to flow all winter beneath the ice. The smaller streams were frozen solid in the winter of 1946–7 and thawed out during the first week of June. At this time small numbers of dead pupae and cocoons of *S. venustum* from the previous season were found attached to stones and vegetation in several of the streams, but no living pupae or larvae were seen, and young larvae did not begin to appear until after the middle of June, two to three weeks before the first adults of this species were on the wing.

By the latter part of July, observations and reports indicated that *S. venustum* had become a more troublesome pest than mosquitoes, their numbers increasing as the latter diminished. Collections at hourly intervals around the clock, on July 24–25, at a point about seven miles east of the camp, revealed that about 90% of the blackflies taken were this species. They were active throughout the day, but none were caught in the hours of darkness between 11 p.m. and 3 a.m.

Many persons experienced trouble from the flies crawling into their clothing and biting various parts of their bodies. One woman in the camp stated that they got into her young son's hair and bit his scalp, resulting in an infection requiring medical attention. Frequently the bites are not felt when inflicted, but later, hard lesions form that may become very itchy (Fig. 9). Sometimes the insects fly about one in clouds and, even when not biting, cause annoyance by getting into eyes, mouth, and ears.

There appear to be at least two generations of *S. venustum* at Churchill and probably three or a partial third, the generations overlapping, so that after the first adults emerge all stages may be found together throughout the short summer season. Apparently development continues until the

streams freeze up. According to an official of the Churchill grain elevator, adult blackflies are present in the area in varying numbers "until the snow flies".

S. venustum is widely distributed and one of the most important pest species of blackflies in Canada (15).

Simulium vittatum Zetterstedt

Female specimens of *S. vittatum* were collected in the open and in the woods at a location east of the Churchill River, south of Churchill, on June 21. These were the first blackflies on the wing, and presumably developed from larvae that had overwintered in the rapids beneath the ice in the Churchill River. The ice went out of the river on June 20. Pupal skins of this species were found on submerged rocks in the rapids close to the shore line, at Mosquito Point, on July 9. The pupae were not found in any of the numerous smaller streams examined in the region.

On July 9, also, great numbers of *S. vittatum* were intermingled with the hordes of mosquitoes on the west bank of the Churchill River. Several sweeps of a midget net caught 264 mosquitoes and 11 males and 52 females of *S. vittatum*. There was no evidence that this species attacked humans.

Of 265 blackflies taken in hourly collections during a 24-hr. period on July 24–25, only two or 0.7% were *S. vittatum*. The locality was about 10 miles east of the Churchill River. If, as observations indicate, the breeding of this species is confined to the river in this area, the distance might explain their scarcity at that point. *S. vittatum* is widespread throughout Canada and occurs in the arctic, females having been collected at Lake Harbour, Baffin Island, by W. J. Brown in August, 1935 (15).

Simulium sp.

The material referred to as *Simulium* sp. consisted of two pupal cases in cocoons collected on a stone taken from the Churchill River rapids at Mosquito Point on July 9. The cocoons are boot-shaped, and the respiratory tufts of the pupae are short and comprised of 16 filaments. The material may represent an undescribed form.

Eusimulium latipes Meigen

This species was found in a shallow, stony, rather swift, little stream or rill (Fig. 10) that has its source in a pool in the camp area and flows through open woods and marshy meadows towards the Churchill River.

Numerous well-grown larvae and small numbers of pupae were found on stones and grasses in the stream on July 3. These were the first blackfly pupae seen in the area. The water temperature was 59° F. By the next day the temperature had risen to 63° F. and pupae were much more numerous. The majority of them were *Eusimulium latipes* Mgn., the remainder being *Simulium venustum* Say. Adults of the latter species began emerging on July 5, and *E. latipes* on July 7. Several collections were made and by

July 12 numerous adults of both species had emerged, the earlier emergences being predominantly males. By this date the pupae in the stream were mostly *venustum*, *latipes* being only sparsely represented.

By July 20, no immature blackfly stages could be found in the stream, nor were any discovered during subsequent examinations on July 28 and Aug. 6.

This species, which is widespread in Europe, was first recorded in North America near Hull, Que., by Twinn (15). It apparently has only one generation a year.

Eusimulium aureum Fries

Six females were collected on July 24, July 25, and Aug. 2. No pupae were found. This species is widely distributed in North America.

Eusimulium species A

Both sexes of this species were obtained from pupae taken from three streams designated in our notes as F.S.B.-E., F.S.B.-M.E., and F.S.B.-W.T., the first being the Eastern Creek, a shallow stream flowing into Hudson Bay five miles east of the camp, the second a small stream (Fig. 11) about midway between Eastern Creek and the camp (dubbed Mideastern Creek), and the third a shallow little stream originating in Lake Isabelle and flowing past the water tower in the camp area towards the Churchill River.

Emergence of adults was actively proceeding from Mideastern Creek on July 6, and may have begun a day or two earlier, as on this date empty pupal skins greatly outnumbered pupae. Newly emerged specimens were crawling up the vegetation in large numbers and many of the flies were also on the wing, but careful observation of them was impeded by the presence of clouds of aggressive mosquitoes. Emergence of this species from the other two streams was in progress about a week later.

This appears to be a single generation species that overwinters in the egg stage, as evidenced by observations on stream F.S.B.-W.T. at approximately weekly intervals from the time the stream began to flow shortly after the thaw in early June, until early August. These data on *Eusimulium* sp. A, breeding in this stream, follow:

June 15 and June 22, no larvae; June 29, large numbers of larvae newly hatched to two-thirds grown; July 4, larvae abundant, many maturing, no pupae; July 12, many pupae adults emerging and mating freely, even when imprisoned in a glass container; July 20, July 28, and Aug. 6, no pupae of this species found, the infestation being entirely *S. venustum*.

Females of *Eusimulium* species A were collected on the wing on July 24 and 25. This is apparently an undescribed species. Dr. Alan Stone, of the U.S. Bureau of Entomology and Plant Quarantine, who has retained the material for further study, states that it is close to *E. minus* D. & S. The pupa has short, bushy respiratory tufts, each consisting of 25 to 30 filaments, arranged mostly in pairs on short stalks arising from a common base. The cocoon is of indefinite shape.

Eusimulium species B

About 10 miles south of Churchill the two main arms of the Warkworth Creek flow northwestward beneath the railway to the Churchill River. The southern arm, about 60 to 100 ft. wide in the vicinity of the railway, is referred to locally as the Goose River.

On July 8, the Goose River was 4 to 5 ft. deep and flowing 3 to 4 ft. per second. The water temperature was 62° F. Blackfly larvae were extremely numerous and pupae and empty pupal cases abundant on the vegetation and stones in the rapids. The majority of the larvae and many of these pupae were *Simulium venustum* Say, but most of the pupae (in collections taken that day) had respiratory tufts each of eight filaments and, from these, emergence of both sexes of a species of *Eusimulium* was general. The species was not recognized and was designated *Eusimulium* sp. B. Emergence was apparently completed by July 14, only the wall-pocket-shaped cocoons and empty pupal cases of this species being found in addition to the abundant immature stages of *S. venustum*.

Pupae and pupal cases of *Eusimulium* sp. B were taken on stones in the Churchill River rapids at Mosquito Point, on July 9, and one pupa was found in collections from Eastern Creek on July 12.

The material has been submitted to Dr. Alan Stone who stated (*in litt.* Jan. 12, 1948): "I do not recognize this and should think that it is an undescribed species. . . . I am holding the specimens for further study."

Eusimulium species C

This species is represented by one female, which emerged by July 12 from a pupa collected from Mideastern Creek (see under *Eusimulium* sp. A), on July 6. The respiratory tufts of this pupa each consist of numerous filaments (30 to 40) branching out on short stalks from the dorsal surface of a stout elongate main trunk. The pinned specimen, with the pupal case preserved in euparal on a piece of celluloid, has been passed to Dr. Alan Stone.

The Tabanids (Tabanidae)

The Species Present

Only a relatively casual survey of this group was possible. The material obtained consists of specimens collected during the course of other work, and is comprised entirely of adult females, no males or immature stages having been taken.

The specimens represent six species of the genus *Hybomitra*, locally called bulldog or moose flies, and four species of *Chrysops*, commonly referred to as deer flies. These species, arranged within the genera in order of abundance are: *Hybomitra affinis* Kby., *H. septentrionalis* Loew, *H. metabola* McD., *H. zonalis*

Kby., *H. hearlei* Philip, and *H. gracilipalpis* Hine, the latter represented by a single female; *Chrysops carbonaria* Wlk., *C. furcata* Wlk., *C. nigripes* Zett., and *C. frigida* O.S.*

Notes on the Species

The succession and relative abundance of these species as indicated by the material available are shown in Fig. 14. The first specimens taken were *H. metabola*, collected on July 5. Three independent reports were received

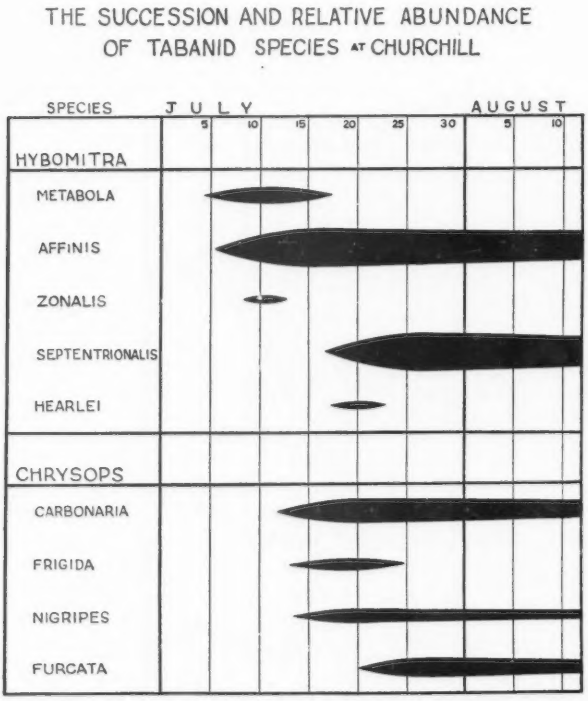

FIG. 14. *Succession and relative abundance of tabanid species at Churchill in 1947.*

of men being bitten prior to this (July 3) by flies that, from their description, could have been tabanids. The first specimens of *H. affinis* were taken on July 6. This rapidly became the dominant species, and remained so until the middle of August (when observations were terminated), although it was in close competition with *H. septentrionalis* from the third week of July onwards.

The earliest species of *Chrysops* to appear was *C. carbonaria*, which was first taken on July 12. This was the most abundant species of the genus until

* *Determinations were made or confirmed by Mr. G. E. Shewell, Division of Entomology, Ottawa.*

towards the end of July, when it gradually gave place to a predominance of *C. furcata*, which, with *C. frigida* and *C. nigripes*, made its first appearance a few days after *C. carbonaria*.

H. zonalis with its striking yellow and black abdomen was remarkable in that it put in an early appearance on July 10, but was not taken thereafter. All the specimens of this species were collected in the camp area.

With the exception of *H. affinis*, no species of either genus was found in appreciable numbers more than a few hundred yards from woodland; this was especially true of the *Chrysops* species, which were seldom taken outside of the woods. The rarer species of *Chrysops* were collected only in woodland some distance from open country.

The abundance of certain species leads to speculation as to the larval food material. Hine (7) successfully reared a number of species of *Hybomitra* on small crustacea and on earthworms, both living and dead. Stone (12) was able to repeat this but found mosquito larvae to be the best food for the young tabanid larvae. It would seem possible, therefore, that the enormous numbers of mosquito larvae stranded from drying pools may form a material element in the diet of one or more species of *Hybomitra*. Cameron (1) states that *Chrysops* larvae will not feed on living animal material.

The adults of several species of *Hybomitra*, *H. affinis* conspicuous among them, are attracted in large numbers to vehicles, including trains as well as the tracked vehicles used in the Churchill area. Numbers of flies would collect around a vehicle (Fig. 12) while an observer standing a few yards away might pass practically unmolested. Stone (12) suggests that they are attracted by the movement, but adds that they will also collect around a standing automobile. This fact was also observed, but in every instance it was around a standing vehicle that had been in motion and was warm in consequence. Warmth appears to be an attractive factor, while movement stimulates pursuit. Certainly it is of no use attempting to run or even to drive away from tabanids over the terrain around Churchill. Specimens that appeared to be *H. affinis* were observed to lose ground only slowly when in pursuit of a train travelling at approximately 30 m.p.h. On the morning of July 12 and a few days subsequent to this, several observers reported a caribou calf apparently separated from the herd, careering madly around the Churchill locality pursued by a small cloud of tabanids. The animal appeared in very poor condition, presumably as a result of the attentions of the flies. Chained dogs, however, were not seen to be attacked by large numbers of tabanids, possibly on account of their inability to run away.

Activity, and especially biting activity, of tabanids is far more influenced by weather conditions than is that of mosquitoes. In cool, damp, overcast, and windy weather few, if any, tabanids were seen on the wing. The weather factors of greatest importance seem to be temperature and sunlight; high relative humidity appears to be associated with absence of biting only secondarily, by virtue of its association with low temperature. Biting was rare at

temperatures below 55° F., and, even above this temperature, would not normally occur unless there had previously been an appreciable period of sunshine on the same day. The well-established preference of Tabanidae for biting through wet skin (13) was confirmed by the observations of personnel working in blackfly streams. During 24-hr. observations on biting fly activity carried out on July 24–25, tabanids were no longer on the wing about a half an hour after sunset. The temperature at that time fell below 65° F. and the light value below 500 lumens per square foot. Activity was not resumed until two hours after sunrise, when the temperature was 55° F. and the light value about 2000 lumens per square foot. *H. affinis* was the most persistent species in each instance, but possibly only apparently so, on account of its greater abundance. The relative freedom of the shore of Hudson Bay from tabanids was more noticeable than its freedom from either mosquitoes or blackflies. Tabanids gained access to buildings in considerable numbers, but caused annoyance there more by their efforts to get out again than by any attempts to bite. In fact, there was no instance recorded of a tabanid biting indoors.

Considerable personal variation in liability to being bitten was noticed. The species of *Chrysops* appear to bite man more freely than do those of *Hybomitra*, but none appears to be a serious biter of man when he is protected by suitable clothing and a good standard repellent such as dimethyl phthalate. All species, however, contribute materially to the psychological menace of the biting fly swarm (mosquitoes, blackflies, and tabanids) that collects about man in this region during the fly season, the *Chrysops* species by virtue of their rather silent approach and furtive alighting and the *Hybomitra* species on account of their swift and noisy flight, and the momentum of their impact on the face and person.

Further survey work on the northern species of tabanids is required to determine what other species occur. No reasonable approach to the problem of controlling the numbers of any one species can be made until the habitats and food materials of the immature stages are more exactly known.

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